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PANORAMIC DRAWING

One Point and Cylindrical Perspective

DEPARTMENT OF MILITARY ENGINEERING

U. S. ARMY

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PANORAMIC DRAWING

One-Point and Cylindrical Perspective

DEPARTMENT OF MILITARY AERONAUTICS
U. S. ARMY

WASHINGTON
GOVERNMENT PRINTING OFFICE
1918

PANORAMIC DRAWING.

General Value of Panoramic Drawing—Conventional Signs.

A panoramic drawing is a picture of a given piece of territory as it would appear to an observer in a balloon. The drawing is not made from the balloon, however, but from a flat map, and for this reason it can be substituted when a photograph could not be taken. There are two kinds of panoramic drawings, the vertical plane or one-point perspective, and the cylindrical plane or many-point perspective. The foundation of the one-point is easier to construct, yet the drawing of the objects requires more judgment; the finished drawing of the cylindrical is the more accurate of the two. We shall confine ourselves to the development of the one-point theory and later to the cylindrical theory.

The average observer going up in the balloon for the first time in a given sector requires anywhere from 20 to 30 hours to feel himself thoroughly at home in his new territory. After having studied a panoramic drawing on the ground, it would be possible for the observer to learn enough of his territory after one or two flights in the balloon to send down intelligent observations. In making panoramic drawings it is necessary to work from a flat map, and this constant association with maps is of great value to an observer. Part of the planning of the Battle of the Aisne by the French consisted in making panoramic drawings, assuming that the desired territory had been won, and that the balloon was then overlooking new territory. The proper study of these maps familiarized the observer so much with this new territory that when he actually arrived with his balloon in the new position he was already familiar with it. Furthermore, the study of flat maps in conjunction with panoramic drawing can be carried on systematically every day on the ground, thus insuring the proper visual memorizing of the sector without wasting valuable time for this work while in the balloon.

Another very important use of the panoramic drawing would be that it gives the artilleryman, for whom we are observing, an idea of how the territory appears to us in the balloon, as well as giving him a good bird's-eye view of the country over which he is working. (Pl. 1a.)

Plate 1a shows us the conventional manner in which different objects appear in perspective and also their flat map convention. Note the difference in the flat map and perspective conventions and remember which is which.

There are two important rules to remember in drawing any object in perspective. One, that parallel lines on the flat map appear closer together as they go farther away, like the rails of a railroad track. Second, that all lines that are vertical on the earth's surface are shown vertical (perpendicular to the base line) in the perspective.

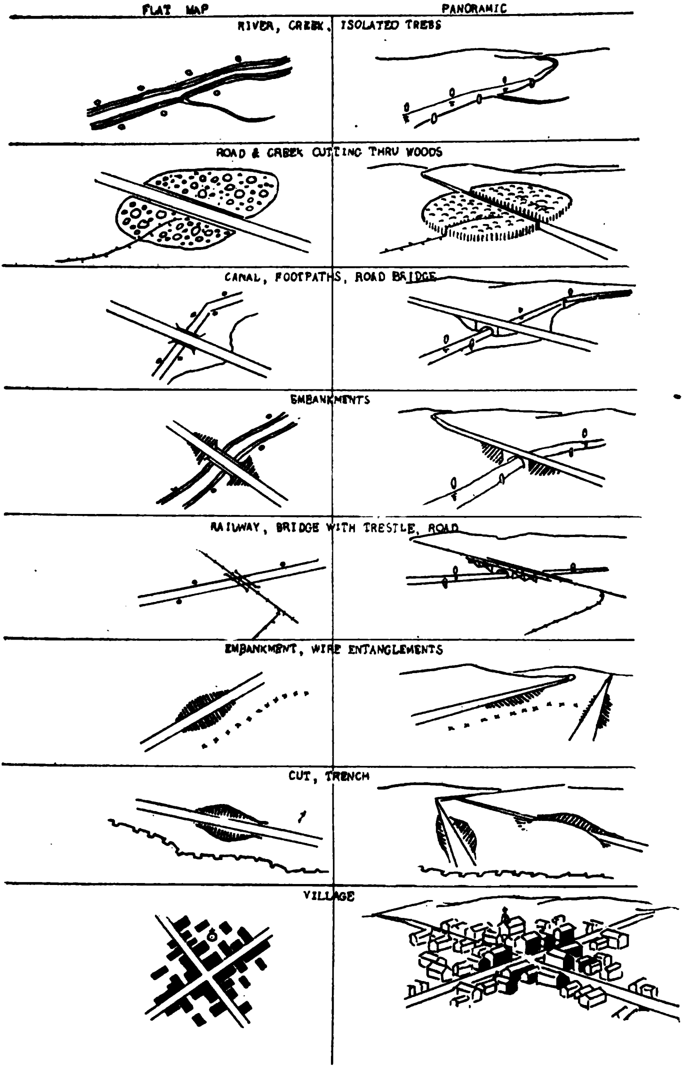
Any feature that can not be designated clearly by drawing should have a brief explanatory note on the perspective. The occasion for use of this method will be rare.

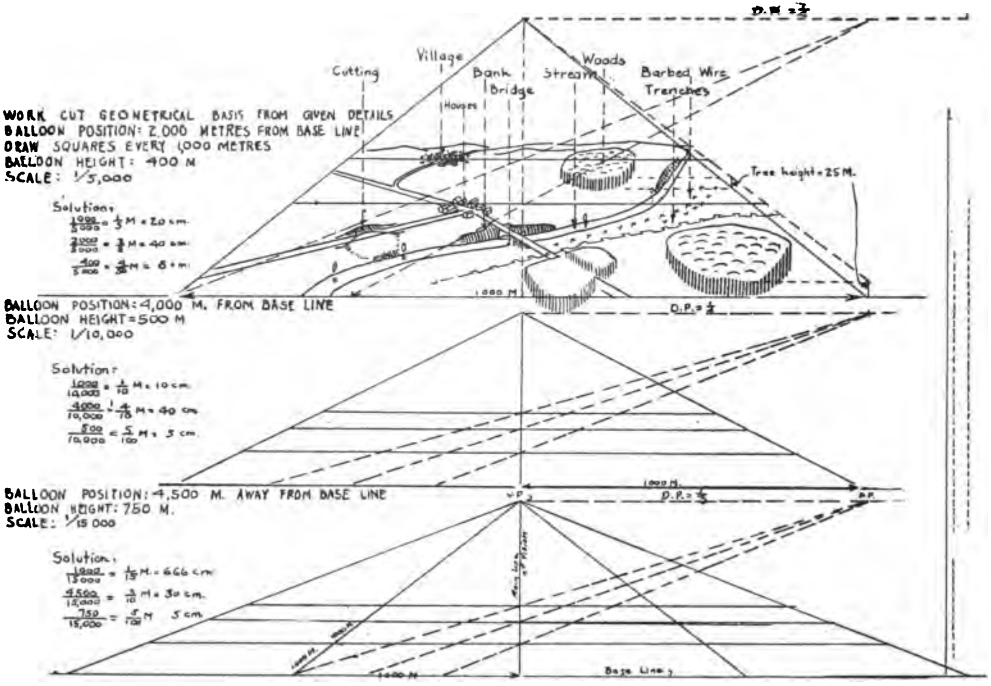
One-point or vertical plane perspective.

Plate 2a shows the geometric basis of one-point perspective and will be referred to below.

However, it would be somewhat tedious to transfer to our vertical plane all the main points on the flat map, so in order to simplify our work and confine ourselves to small sections, we construct on our vertical plane or picture plane the 1,000 meter lines

CONVENTIONAL SIGNS.


FLAT MAP
PANORAMIC
RIVER, CREEK, ISOLATED TREES
ROAD & CREEK CUTTING THRU WOODS
CANAL, FOOTPATHS, ROAD BRIDGE
EMBANKMENTS
RAILWAY, BRIDGE WITH TRESTLE, ROAD
EMBANKMENT, WIRE ENTANGLEMENTS
CUT, TRENCH
VILLAGE



WORK CUT GEOMETRICAL BASIS FROM GIVEN DETAILS
BALLOON POSITION: 2,000 METRES FROM BASE LINE
DRAW SQUARES EVERY 1,000 METRES
BALLOON HEIGHT: 400 M
SCALE: 1/5,000

Solution:
$\frac{1000}{5000} = \frac{1}{5}$ M = 20 cm.
$\frac{2000}{5000} = \frac{2}{5}$ M = 40 cm.
$\frac{400}{5000} = \frac{4}{50}$ M = 8 cm.

BALLOON POSITION: 4,000 M. FROM BASE LINE
BALLOON HEIGHT = 500 M
SCALE: 1/10,000

Solution:
$\frac{1000}{10,000} = \frac{1}{10}$ M = 10 cm.
$\frac{4000}{10,000} = \frac{4}{10}$ M = 40 cm.
$\frac{500}{10,000} = \frac{5}{100}$ M = 5 cm.

BALLOON POSITION: 4,500 M. AWAY FROM BASE LINE
BALLOON HEIGHT: 750 M.
SCALE: 1/15 000

Solution:
$\frac{1000}{15000} = \frac{1}{15}$ M = 666 cm.
$\frac{4500}{15,000} = \frac{3}{10}$ M = 30 cm.
$\frac{750}{15,000} = \frac{5}{100}$ M 5 cm.

of the flat map only. These lines which bound the 1,000 meter squares on the flat map represent, when projected on the vertical plane, the geometric basis or skeleton work of one-point perspective. We shall now construct the 1,000-meter squares in perspective.

For the sake of simplicity we have taken our main line of vision along one of the thousand meter lines of the flat map. Then we will have one set of thousand meter lines which run parallel to the main line of vision and another set which runs perpendicular to the main line of vision.

First, we shall draw in perspective all meter lines parallel to the main line of vision. We shall find that our main line of vision will be projected vertically on the piece of paper. All other lines actually parallel to it will be projected on the piece of paper in such a manner that they shall be 1,000 meters apart on the base line, and meet at a common point on the main line of vision, as far above the base line as the balloon is high in the air. Next, we shall project those 1,000 meter lines which are at right angles to our main line of vision. To do this we must take a sectional view of our vertical plane, balloon position, and territory on a separate sheet of paper (fig. 2, plate 2a). Looking at the section or in direction B, then the map surface will be represented by a horizontal line ZY, the vertical plane by a vertical line VX, the balloon in its position according to its height and distance away from the vertical plane. Every thousand meters along the horizontal lines we shall mark points which represent the 1,000 meter lines which are at right angles to our main line of vision. By connecting these points to our balloon by means of straight lines, such as A, B, P, we can determine their points of contact with the vertical plane (fig. 2), which relative points we can then transfer to our front view (fig. 3). We then draw these lines parallel to the base line and through the relative points just found. We now have both sets of 1,000 meter lines represented in perspective. They constitute the geometrical basis of one-point perspective.

It is now necessary to picture by means of the conventional signs furnished that territory which lies in each particular square.

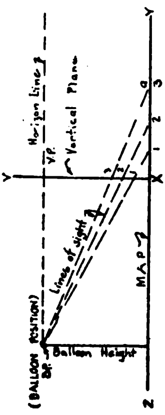
Problem 2 consists in drawing the geometric basis for three different sets of conditions.

METRIC SYSTEM.

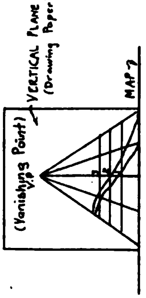
1 km. (kilometer)=1,000 meters=1,093 yards.
1 m. (meter)=10 decimeters=39.37 inches.
1 dm. (decimeter)=10 centimeters.
1 cm. (centimeter)=10 millimeters.
1 inch=2.54 centimeters.
328 feet=100 meters.

Perspective Taken at an Odd Angle.

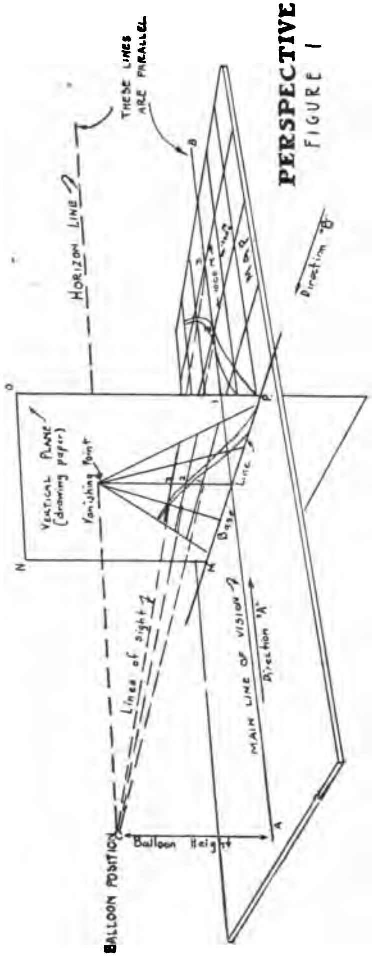
In lesson No. 4 our main line of vision was taken along one of the thousand-meter lines. This time we shall take it at an odd angle with these thousand-meter lines. We will proceed as follows: From our balloon position in plan we shall draw a straight line (A B) through the heart of the territory; this line shall represent our main line of vision. Next, we shall draw our base line close up in front of our territory and at right angles to the main line of vision. We shall then draw on the flat map a single 1,000-meter square, a, b, c, d, having one set of its lines parallel to the base line. From the previous explanation (lesson 4) we know how to set this square in perspective. Having done so, we plot the position of any of the thousand-meter lines that lie in this square in our perspective sheet, being sure to pick out two which are at right angles to each other on the flat map. In perspective these two lines extended will cross the horizon line at two points, one on either side of the vanishing point. All other 1,000-meter lines parallel to either of these first two will meet in perspective at



SECTION
Looking in Direction "B"
FIGURE 2



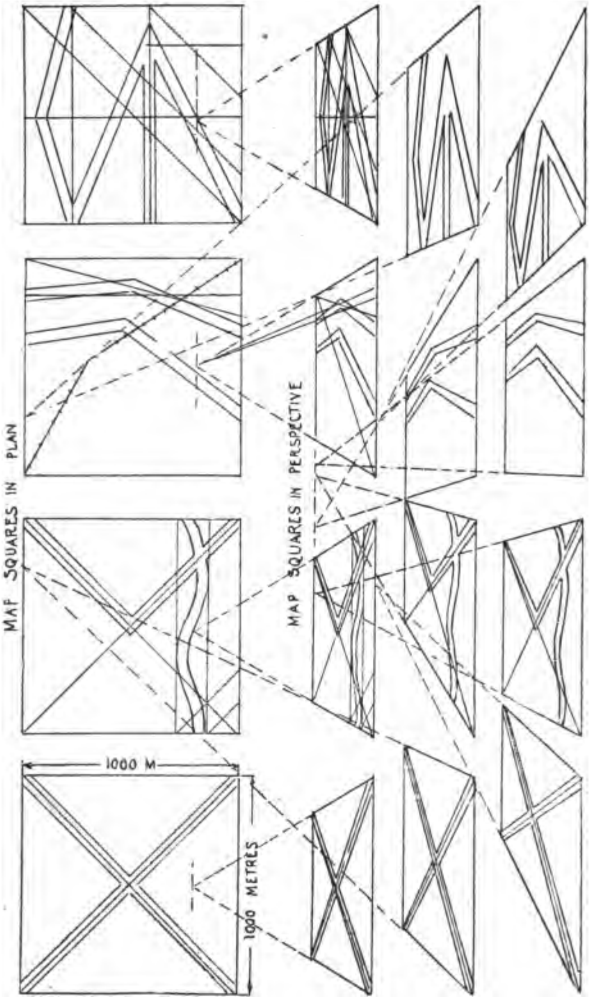
FRONT VIEW
Looking in Direction "A"
FIGURE 3

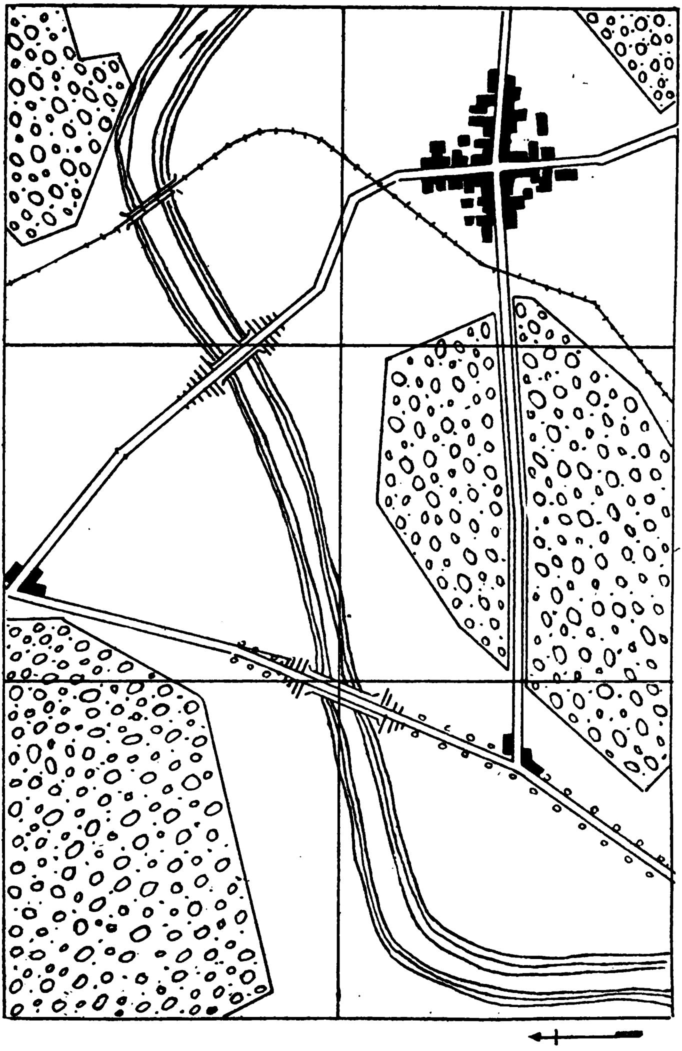


PERSPECTIVE
FIGURE 1

NAME (IN INK)________________________________

SECTION NO. (IN INK)________________________________ DATE________

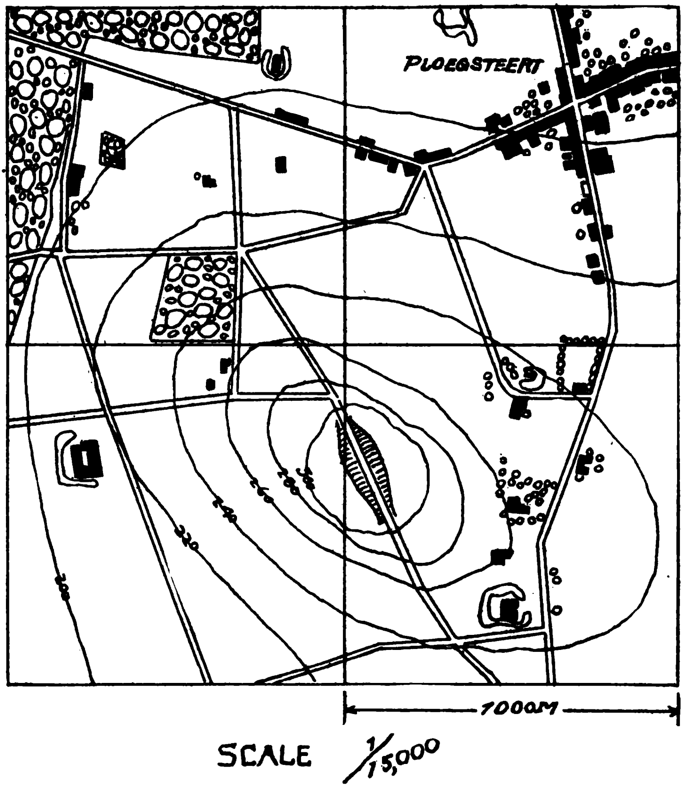




SCALE 1/15,000

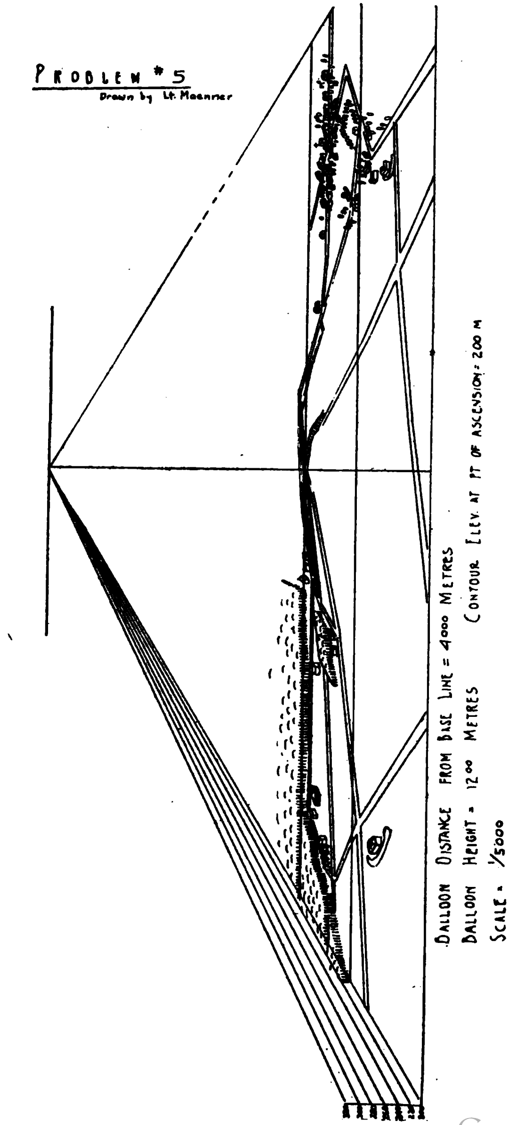
Ploegsteert and vicinity.

The problem is to be solved according to the contours; that is, the distortion which takes place because of these must be worked out.



DATA.

Balloon distance from Base Line 4000 M.
Balloon height 1200 M.
Contour elevation at points of ascension 200.
Scale 1/5000.


Problem #5
Drawn by Lt. Moenner
Balloon Distance from Base Line = 4000 Metres
Balloon Height = 1200 Metres
Contour Elev. at Pt of Ascension: 200 m
Scale = 1/5000

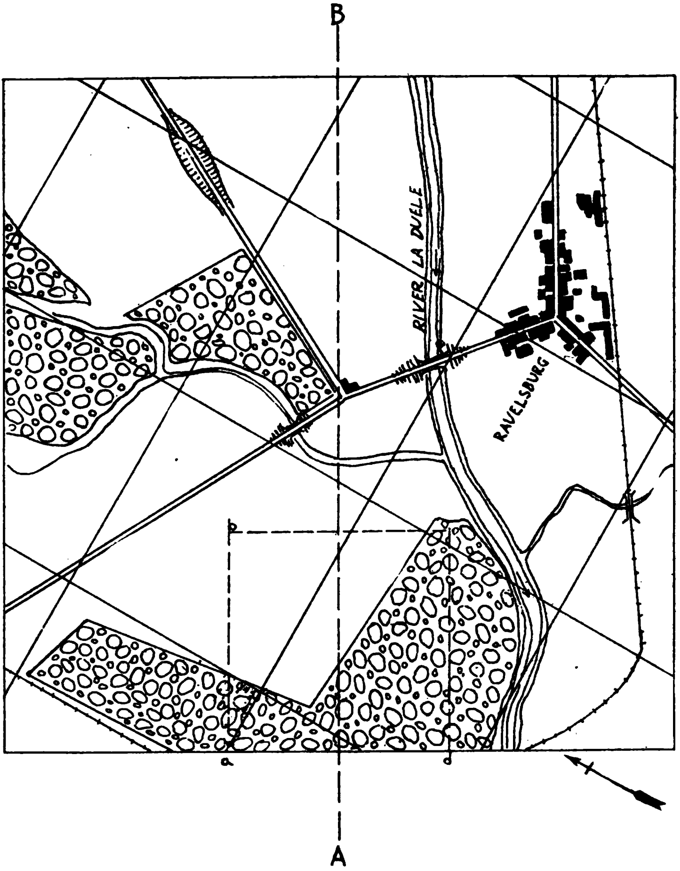
either of the above points on the horizon line. We can plot the points where they cross the base line.

Problem No. 6 consists in the employment of the odd-angle point of view.

Contours, Visibility, and Dead Areas.

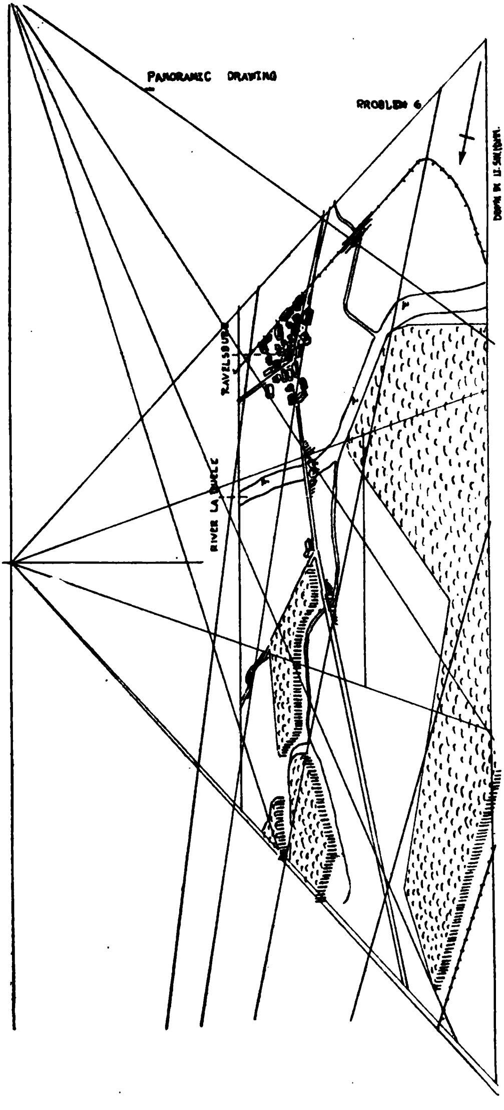
A contour is defined as an imaginary line connecting points of equal elevation on the earth's surface. It is the important duty of the intelligence officer of every company to lay out on separate flat maps the exact territory that will be in defilade from his balloon at various heights. The French draw out the dead area for three heights of the balloon, namely, 800 meters, 1,000 meters, and 1,200 meters. An experienced man could work out the dead space for all heights on the same map, different colored crayon being used for the different heights. This information is particularly useful at the nightly conference at Corps Air Headquarters in determining whether the balloon observer or airplane observer should take the observation of fire on particular enemy batteries the following day, as the map shows at once whether these batteries are visible or not from the balloon.

Let us work out the dead ground, being given the flat map showing a hill by means of contour lines, the balloon position, and its height (fig. 1, plate 10a). The line AC drawn through the balloon position and the center of the hill, represents a vertical plane cut through the earth's surface. A section through the hill along this plane will look as indicated (fig. 2). Our view of the earth's surface will disappear on the hill at the point X, and be resumed at the point Y. The exact horizontal distance of these two points from the balloon is next measured and transferred back to the plan. We now have two points on the line AC between which it is impossible for us to see any territory. By drawing five or more such lines as AC in plan and laying out the corresponding sections,



SCALE 1/20,000

The problem is to make a perspective drawing of the above map, having the base line and main line of vision at an odd angle to the 1,000 m. lines. It is first necessary to draw in a 1,000 m. square, as shown by *a, b, c, d.* Data: Balloon position, 3,000 m. SW. of territory. Balloon, 1,400 m. high. Perspective to be drawn at the scale of 1/10,000.


PANORAMIC DRAWING
PROBLEM 6
DRAWN BY LT.
RAVELSBUR
RIVER LA

we can ascertain in plan the exact amount of dead ground which the hill makes.

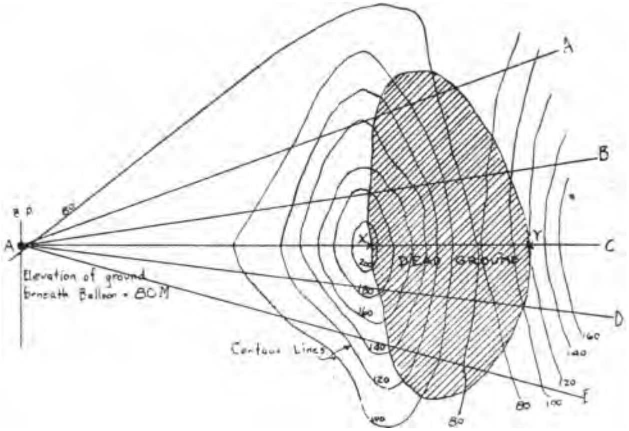
To find the dead ground by the map distance method, proceed as follows: As in the previous case, run one section, as AC, and plot the hill, exactly as explained. Our line of sight makes a certain angle with a horizontal line. Two adjacent contour elevations will cut this line of sight at two points which are the distance ST apart, horizontally. It is evident that for a steeper slope, such as this hill, the two points ST will be closer together horizontally. Therefore, if we find in the plan, any two contour lines on the far side of the hill which are closer together than these distances, we know that such territory will be dead ground or will be in defilade. This system, although not as accurate as the first one, is a timesaver requiring but one section to be drawn for each hill, and is invariably used for cylindrical perspective drawings.

Problem No. 10 consists in finding the dead ground by means of five or more sections.

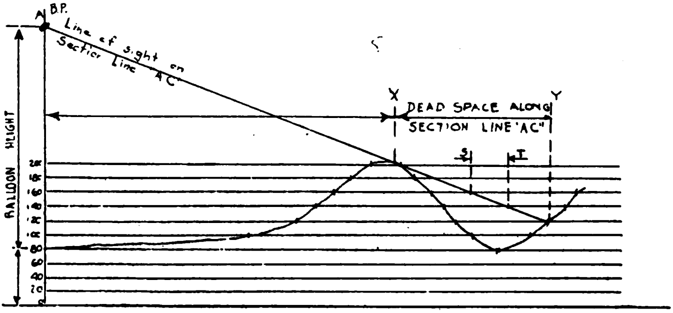
Cylindrical perspective.

Thus far in the development of our study of perspective we have failed to consider two important factors. First, we have drawn a straight base line at right angles to our main line of vision and considered the balloon position equally distant from all points on that line. This is not actually true. Second, we have drawn every perspective as if the ground were perfectly flat. This is not often the case. In order to properly solve these two factors, we shall make use of the cylindrical perspective.

Consider plate 11a. Here we show the base line as an arc (A B) of a circle with the balloon position (B. P.) in plan as its center. Now our picture plane A, B, C, D (P. P.) will be a plane erected vertically on this arc (A B) and our picture plane (P. P.) or paper will be a cylindrical plane instead of a flat plane as heretofore.



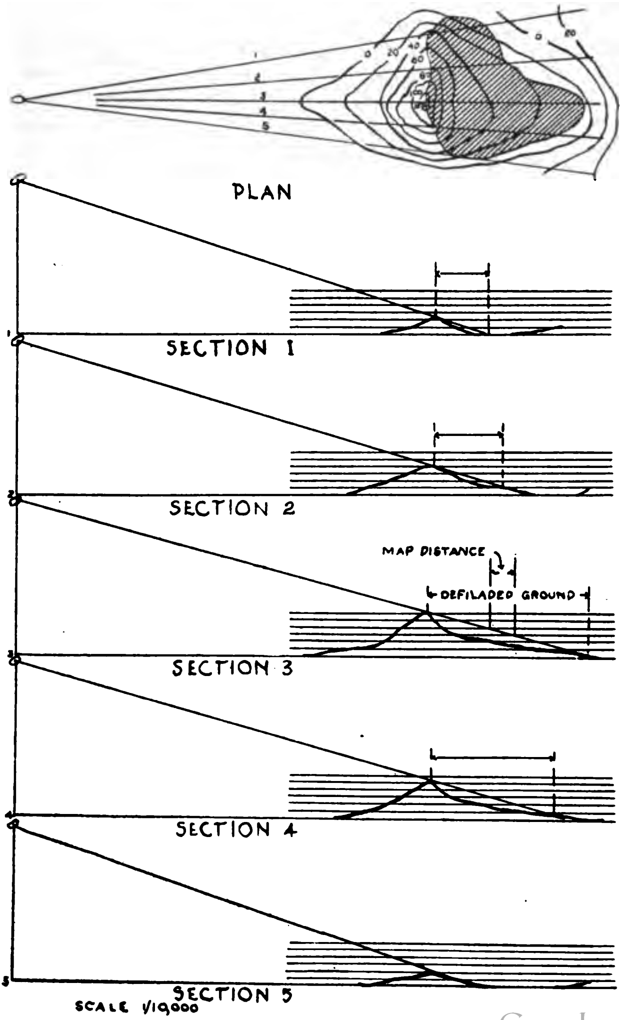
FLAT PLAN OF HILL
FIGURE 1.


A
B.P.
Line of sight on Section Line "AC"
X
Y
DEAD SPACE ALONG SECTION LINE "AC"
S
I
BALLOON HEIGHT
200
180
160
140
120
100
80
60
40
20
0

SECTION OF HILL ON LINE "A C"

NAME (IN INK)..PROBLEM 10.

SECTION NO. (IN INK)..DATE________



Now we have all points on the base line equidistant from the balloon position (B. P.) in plan. Furthermore, we can see that by drawing the sections of the territory we shall be able to take into consideration the contour of the ground.

We note that the base line and territory back of the picture plane (P. P.) is divided in a horizontal direction by radii passing through the territory from B. P. (balloon position). As all of these lines radiate from the balloon, they all would appear, when projected in perspective onto the P. P., as vertical lines drawn on the P. P., one at each point where a radius intersects the base line (A B), as E F and G H. Therefore we can see that these vertical lines on the perspective represent the same divisions as the radii do on the first map. That is, if a point was between the two certain radii on the flat map, in perspective the same point would be between the two vertical lines representing these two radii. As can be seen by the horizontal lines J, K, L, M, N, O, the P. P. is divided also equal vertical divisions which will be explained later.

It is evident that the map squares would be of no special advantage to us in this case, so we shall disregard them for the present and reline our ground on the flat map. (See plate 11b.)

With the B. P. as our center we shall draw an arc (A B) 6 km. (kilometers) from the B. P. It represents the base line of our picture or cylinder. Every 200 meters, at the same scale as the flat map, let us draw similar arcs (1, 2, 3, 4, etc.), representing secondary cylinders. We next draw in the radiating lines, extending from the B. P. through points on the cylinder or base line which are all 5 mm. (millimeters) apart. This 5 mm. is measured directly on the cylinder or base line and is not reduced to scale. We now have our map relined. For convenience in locating points, it is best to number the lines as shown on plate 11b.

The next important step is to locate the defiladed area on the map. This is fully explained in lesson 10 and requires that a typical section of the ground be made. This can be made on any radius line. Then by checking the map distances (M. D.) between contours, the apparent top of the hill can be laid out as shown in plate 11b. Figure 1, plate 11c, shows the application of the theory of the section. For greater convenience in working, the horizontal scale is kept the same, i. e., 1/20,000, while the vertical scale is increased 10 times, i. e., 1/2,000, as shown in figure 2, plate 11c. The base of the section is considered to be at the same altitude as the ground directly beneath the B. P. The difference between vertical and horizontal scale does not alter the accuracy of the work, as it is a case of similar triangles.

For ease in locating points on the P. P., this P. P. or cylinder is divided up horizontally by the lines J, K, L, M, N, and O, as shown in plate 11a. These lines are 1 mm. apart, when considered at the scale of 1/20,000. Upon increasing the vertical scale 10 times in the typical section, this millimeter becomes 1 cm., as shown by points A, B, C, D, etc., on the cylinder. By drawing lines from B. P. through these points and to the base of section, we divide the territory up in a uniform manner in relation to P. P. In other words, a point in the territory back of the P. P. or cylinder would appear from the B. P. to be on one or between two certain lines located on the cylinder. In that way we can locate the height of that point on the P. P. or cylinder. At all times remember that this section is always the same regardless of where it passes through the territory as long as it is taken through the B. P. as one end. The division of the horizontal distances remain the same as on plate 11b, i. e., 200 meters. The vertical contour interval of 20 m. (meters), as shown by the flat map, plate 11b, is drawn in at the vertical scale of 1/2,000. At this scale it equals 1 cm. on the section as shown. All these points must be marked. We are now able to locate accurately on the section the exact position of points taken from the flat map, plate 11b.

First let us construct our geometrical basis of the perspective as shown in plate 11d. This is done at a scale of 1/5,000 or just four times the scale of the flat map. This is a usual scale to take. In a horizontal direction the perspective view is divided into lines as it was on the flat map, i. e., 5 mm. apart. At this scale of 1/5,000, they become 20 mm. or 2 cm. apart. Vertically divided lines of the P. P. are 1 mm. apart, as explained before. At this scale they become 4 mm. apart. Points on this drawing should also be lettered and numbered to correspond to relative points on flat map and section.

In drawing the finished perspective it is first necessary to locate those lines which represent from the balloon position the top of each hill. This is done by locating points on one of these lines. Let us take point Z, on plate 11b. It is the point where the line of the hill crosses the contour line 300. In locating this point on the flat map we first find that it lies between the secondary cylinders 6 and 7, closer to 6. In relation to the radii we find it between m and n and closer to m. In locating this point on the section we find the vertical lines 6 and 7 representing the secondary cylinders. The point is between these two lines and closer to 6, as shown by dotted lines Z—Z′ in plate 11c. On the flat map we see it is also on contour 300. We have our contour intervals plotted on plate 11c, so where the dotted line Z—Z′ intersects line 300 is our point Z.

Connecting this point with the B. P., we find that the line cuts the cylinder between N and O, and closer to N. Turning now to our perspective sheet (plate 11d), we find the line on which is located our point with relation to the corresponding horizontal lines N and O. Now where does the point lie with respect to the right or left side of the perspective sheet?

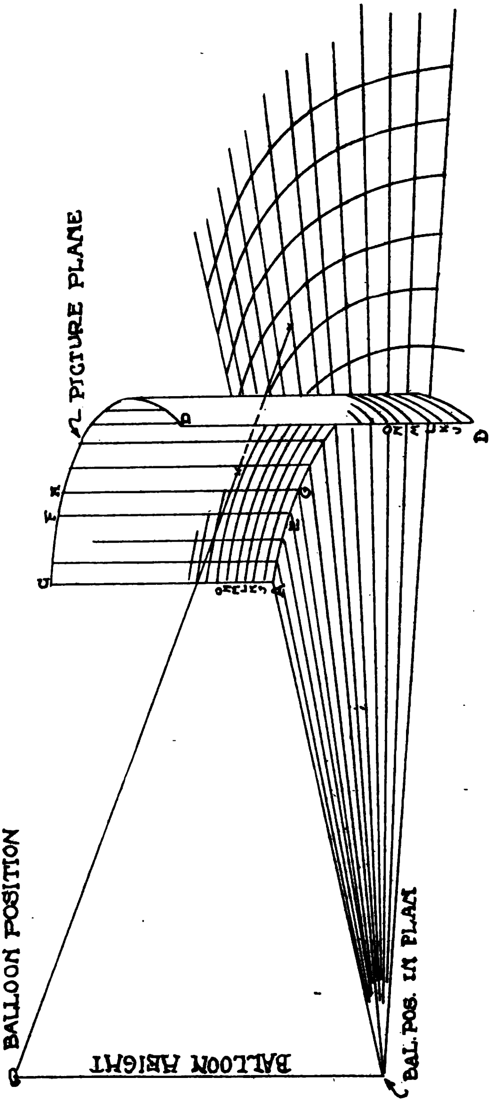
Turning to our flat map (plate 11b), by projecting the point toward the B. P., it cuts the cylinder between m and n and closer to m. Moving to the perspective sheet, we find a vertical line on which is located our point with relation to the corresponding vertical lines m and n. The point of contact of the vertical line with our newly found horizontal line represents the point Z in perspective. Other points in the line of the hill can be plotted in the same manner and finally the hill drawn in its proper location, as shown. After this, the most important items are the location of the important roads and railways and later the woods, creeks, trenches, etc. In locating trees and houses always remember that they have a certain height above the ground that should be added to the height of the ground upon which they stand in order to find the top of them. Trees are to be considered 70 feet high.

Take flat map, plate 11e, and draw a cylindrical perspective of it. Balloon position 6 km. back and 1,200 meters high. Elevation of ground beneath B. P. is 200 meters.

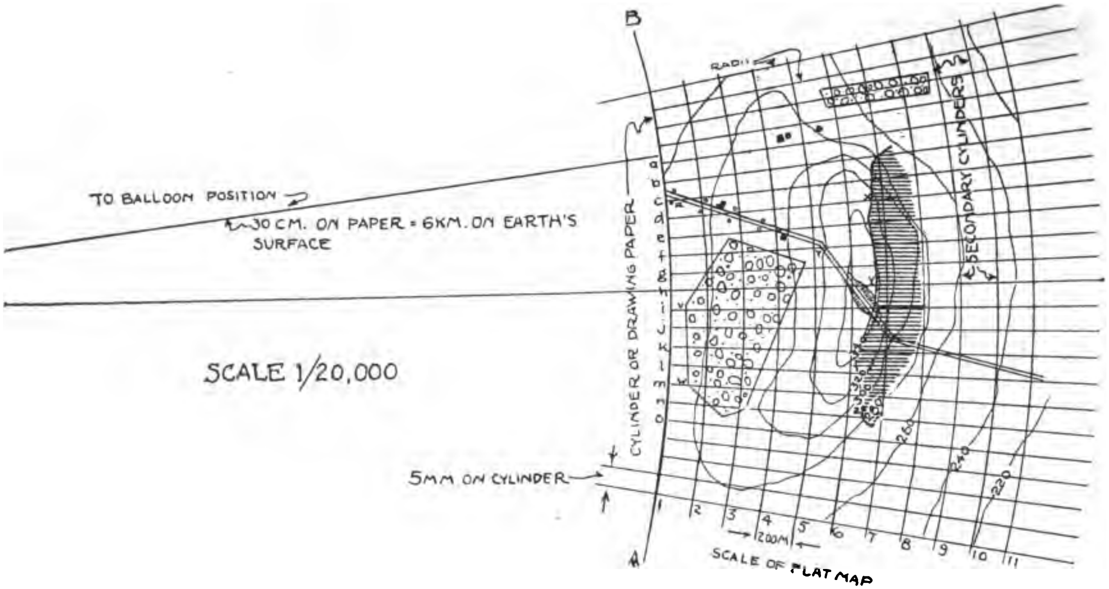
Color Work.

In drawing the perspectives of country, if we have only the tops of hills located and nothing to show the slope of the ground, the map will seem unintelligible except to the trained eye. Even then mistakes could easily be made. To overcome this the picture could be colored up with crayons portraying the slope of the ground in the same manner that an artist does in making a picture. The man who has had no previous experience in this work will find it best to get some good examples of landscape work and copy the colors and shading. This could be accomplished by obtaining colored prints of pictures by recognized landscape painters.

A method that would also be good and which will be within easy reach of all is to make a careful study



CYLINDRICAL - EXPLANATION SHEET



CYLINDRICAL - EXPLANATION SHEET

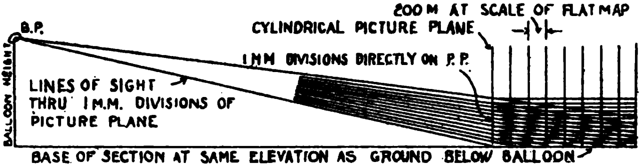

200 M AT SCALE OF FLAT MAP
B.P.
CYLINDRICAL PICTURE PLANE
BALLOON HEIGHT
1 MM DIVISIONS DIRECTLY ON P.P.
LINES OF SIGHT THRU 1 M.M. DIVISIONS OF PICTURE PLANE
BASE OF SECTION AT SAME ELEVATION AS GROUND BELOW BALLOON
CONTOUR INTERVALS SHOULD ALSO BE PLOTTED IN AT SCALE OF FLAT MAP.

FIGURE 1

THEORY OF SECTION

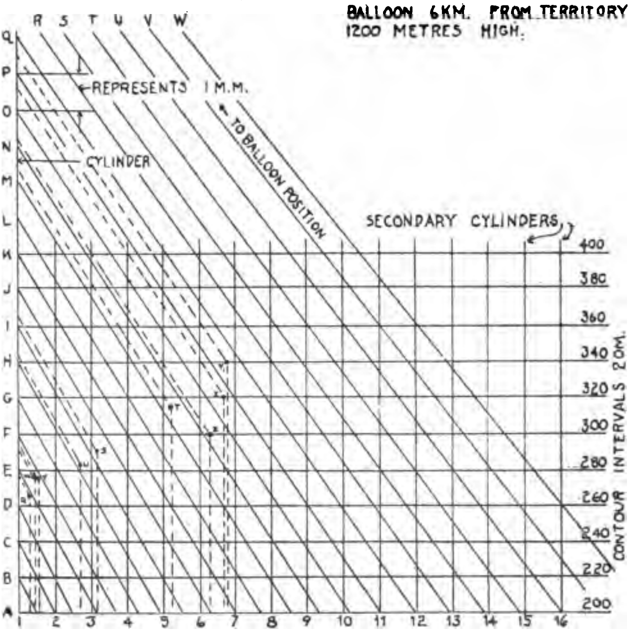
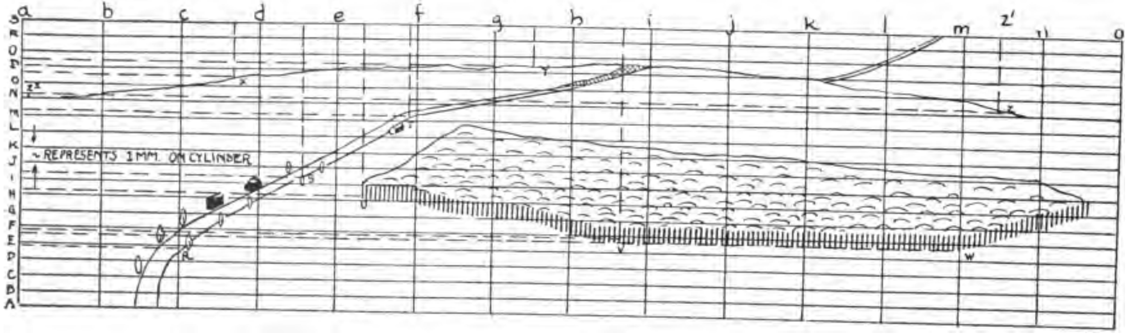


FIG. 2 TYPICAL SECTION OR ABAQUE

HORIZONTAL SCALE = 1/20,000
VERTICAL SCALE = 1/2,000

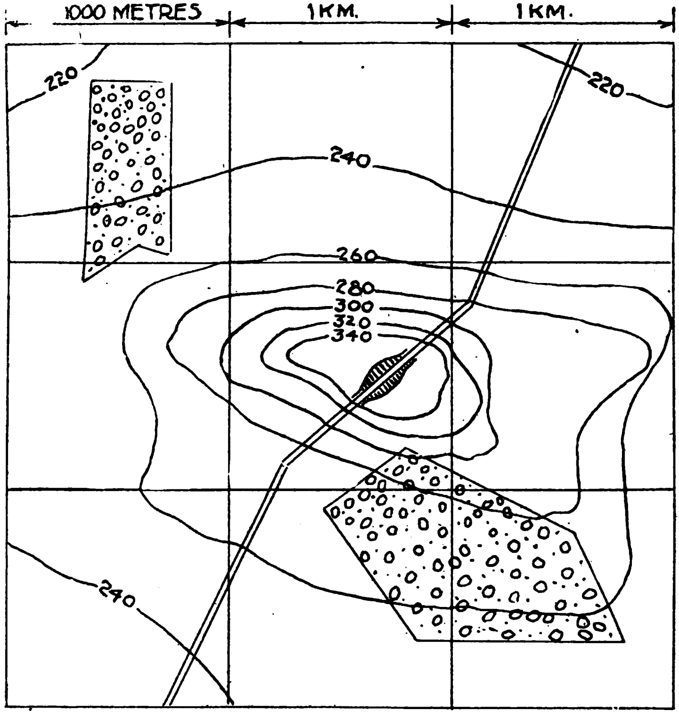
CYLINDRICAL - EXPLANATION SHEET



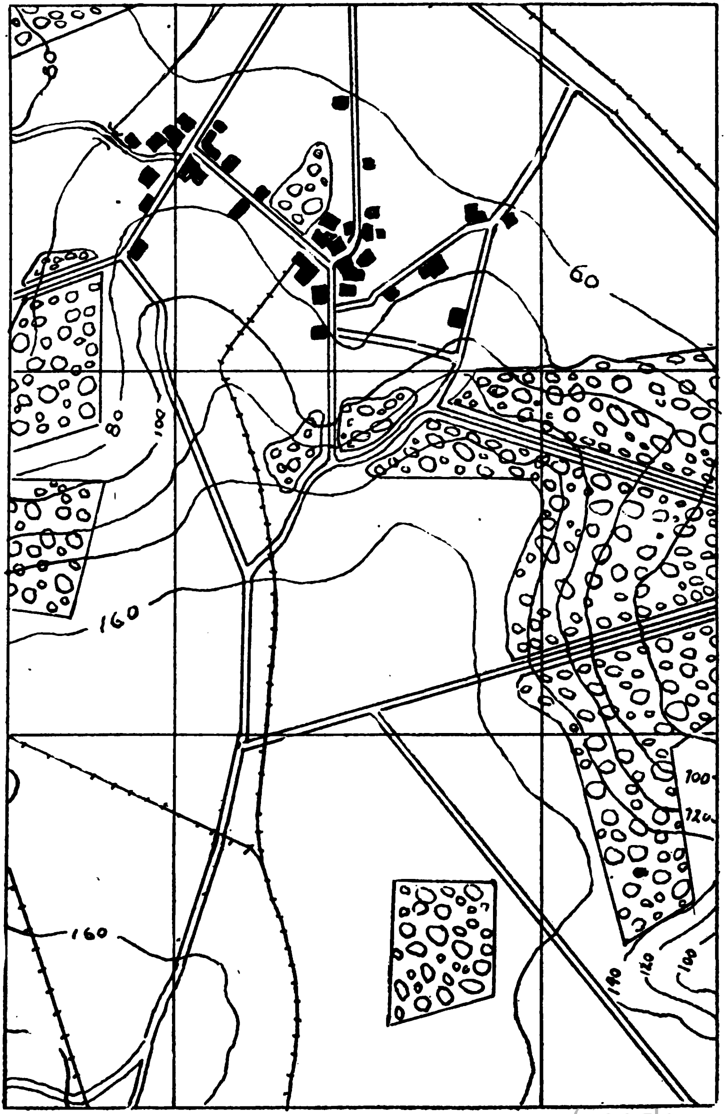
PANORAMA OR PERSPECTIVE WITH BASIS
SCALE 1/5,000

CYLINDRICAL - EXPLANATION SHEET

of photographs. Here we find the shading of hills and valleys in black and white. With a soft pencil and a certain amount of rubbing the shading could be accomplished and perhaps the shades somewhat exaggerated in order to bring out our picture more clearly.



There are a few points that must be remembered at all times in putting in this shading. First is the fact that the position of the sun must be established so that we may figure out which part is in light and which in shadow; second, that hills and objects closer to us


80
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140
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100

are always more distinct and darker. Hills farther away become more indistinct, lighter, and grayer. Success in the application of this shading will depend upon the student's capacity for keen observation of the photographs, ability to distinguish degrees of light and shade and carefulness in its application to the perspective drawing. Much practice will be required.

How the French Make Panoramic Drawings.

In making their perspectives the French proceed as follows: The geometrical basis is laid out on detail or other heavy paper; principal elements are outlined. Then these elements are traced off on tracing paper, but the geometrical basis is left out. All lines are then inked in; sometimes different colored ink is used, such as purple for trenches. Next the different elements are colored with pastelle crayon, such as the woods, green; houses, red; terrain, brown; etc. The tracing is then stretched over the back of an old map or other handy paper. This is an extremely simple and quick method of turning out a drawing.

Standard Scales.

The following are the usual standard scales used in making perspectives: All work is usually done from a 1/20,000 map or 1/10,000 map; B. P. always 4 km., 5 km., or 6 km. back, 800 meters, 1,000 meters, or 1,200 meters high; sections constructed with horizontal scale 1/20,000 and vertical scale 1/2,000. Perspective always four times size of map.

Usually the map man will have these standard scale plottings and sections and perspective bases all laid out and ready for use. This aids greatly in saving time when a perspective must be made in a hurry.

These maps are not a daily occurrence in the routine of a company, but in the case of a rapid advance upon new territory there would be one made for each new balloon position.

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